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ABSTRACT

This study investigated the effects of an 18/1 versus a 30/1 student-instructor (S-I) ratio on instructor behavior and student achievement in a computer-managed Navy technical school. Students were randomly assigned to two learning centers in which in 18/1 S-I ratio was maintained, while a 30/1 S-I ratio was maintained in two other learning centers. These learning centers were operated identically for four months, except for the difference in the S-I ratio. Student achievement measures obtained from the computer system included course completion times, knowledge test scores, performance test data, and student attrition rates. The data indicate that increasing the S-I ratio from 18/1 to 30/1 proportionally increased the frequency of required administrative interactions between student and instructor. Under the higher S-I ratio less instructor time was available to the student for direct instructional contact. There was no significant difference in student achievement measures or attrition rates as a result of the different S-I ratios, but there was some evidence of a performance decrement. The results indicate that a 30/1 S-I ratio can be used effectively in a learning center environment. (Authors)

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Effects of 18/1 and 30/1 Student-Instructor Ratios on Student Achievement and Instructor Activities in a Computer Managed Course

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In recent years the use of self-paced, individualized instruction has become widespread, with computer management of instruction (CMI) becoming increasingly important in both civilian and military academic applications. The purpose of this study was to assess the effects of 18/1 versus 30/1 student-instructor ratios on: (a) student achievement and (b) instructor behaviors in a Navy CMI technical training course concerning Basic Electricity and Electronics (BE&E). This study represents one of the first attempts to determine empirically the effects of different student-instructor ratios on student achievement in an operational CMI learning center. If the Navy CMI Learning Centers could be operated with larger student-instructor ratios, savings could be achieved both in terms of instructor time and school operating costs. The question is, however, can the Navy obtain these savings without adversely affecting student achievement and instructor behavior?

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In an attempt to answer this empirical question, four learning centers at the BE&E School (two operated during the morning shift and two operated during the afternoon shift) were observed over a period of four months in the fall of 1977. Each shift lasts for 6 consecutive hours. During both the morning and afternoon shifts, one learning center was maintained at an 18/1 ratio, with the other maintained at a 30/1 ratio. These ratios were maintained throughout the study by randomly assigning newly-entering BE&E students whenever vacancies occurred in any of the Learning Centers. For the four Learning Centers there was a total of 235 students who provided achievement data: Seventy-seven students from the 18/1 Learning Center and 158 students from the 30/1 Learning Center. In general, students in the BE&E course at San Diego, California generally require 25 to 45 days with 6 hours per day to complete training. Since not all students are in the same career path, training times will vary because of individual differences in learning speed and because different career paths call for a varying number of instructional modules in BE&E.

Instructors participating in this study were four volunteers from the BE&E instructor pool. In order to control for bias, instructors were assigned to a Learning Center using one student-instructor ratio for half the duration of the study and then were reassigned to the other student-instructor ratio during the same shift for the second half of the study.

Effects of student-instructor ratios on instructor behaviors were investigated by observing and recording the frequency and duration of activities the instructors engaged in during the six-hour instructional shift. A classification system for these instructor behaviors was

developed through a series of pilot observations. This system consisted of seven different categories covering all activities performed by an instructor during an instructional period.

The seven instructor behavior categories included the following: (a) Testing, in which the instructor passes out or receives test microfiche cards, answer sheets or booklets, and remediates a student on test questions; (b) Administrative-Student, in which the instructor interacts with the student on a one-to-one basis for non-instructional, administrative duties such as indoctrination procedures or signing a student in or out of the computer in the Learning Center; (c) Administrative-Non-student. This category includes all administrative duties that involve no personal contact with the student, such as filing of papers, filling out forms, or school-related conversation with other staff members; (d) Question. This category involves the instructor answering technical questions about course content or giving instructional and tutorial aid; (e) Practical. This category involves scoring and remediating the two performance tests completed in the Learning Centers (f) Non-school. This category involves any instructor conversation with individuals when a non-school matter is discussed; and (g) Other. This category covers those times when the instructor is not involved in any specific behavior, but is waiting for a student interaction or is on a break and absent from the Learning Center.

Research personnel observed each instructor for four complete six-hour shifts under each student-instructor ratio. The observers recorded how often each of the seven categories of behavior occurred, as well as the duration of each interaction. The length of time each student waited

in line to see the instructor was also recorded. Four observers were involved in rating instructor behaviors. To obtain a measure of inter-rater reliability, all four raters simultaneously observed an instructor for one hour. Inter-rater reliability was high, with a Kendall coefficient of concordance of .93, resulting in a $\chi^2_{(7)}=26.04$, $P<.001$.

Results of this study will be presented in terms of (a) student achievement, and (b) instructor behaviors. In order to make comparisons of student achievement under the two student-instructor ratios equitable, it was necessary to divide the samples into groups of students who received the same pattern of instructional modules, according to their respective career paths. The only consistent effects of student-instructor ratio on student performance occurred with respect to total training contact hours. As can be seen from Table 1, the data indicate that the 30/1 student-instructor ratio generally results in a higher average number of training contact hours in this BE&E course than does the 18/1 ratio. Although the mean difference was statistically significant only for Pattern 2, the difference for the other patterns are operationally important since training time means dollars lost. In terms of other measures of student performance, there were no consistent effects as a function of student-instructor ratio. As can be seen in Table 2 of your handout, the mean first-try module test scores for Mods 1-14 were highly similar among the four career paths for both ratios. The first-try scores are those obtained prior to any remedial testing experience. There are no consistent indications fromthe data that either student-instructor ratio detrimentally affected first-try scores. The data for Mods 15-25 also indicated that mean first-try scores were similar for both student-instructor ratios.

Table 3 depicts the mean number of unsatisfactory scores, or "unsats," received on practical tests during the course. While there was a significant difference in "unsats" for Career Path 3, there were no consistent results to attribute the differences to a particular ratio.

In terms of instructor behavior, the data suggest that the 30/1 ratio, in comparison to the 18/1 ratio creates a Learning Center environment in which the instructor has a greater burden when dealing one-to-one with students, which is met in part by reducing the time spent in answering individual student's technical questions and in part by reducing the time spent in "Other" type activities. This can be seen in Table 4, which depicts the mean proportion of the instructional hour that an instructor performs each behavior category. Only the difference between the means in the "Administrative-Student" category even approaches significance ($p<.10$), with instructors spending a greater proportion of their time on this behavior under the 30/1 ratio. Even though the difference did not approach significance, perhaps due to large variance, the evidence shows that in fact there was also quite a bit less time spent in "Other" type activities by the 30/1 instructors than by the 18/1 instructors.

By looking at Table 5, in which mean time per instructor behavior is depicted, we can see that the "Question" category has significantly less time per hour devoted to it ($P< .05$) in the 30/1 ratio than in the 18/1 ratio. So it appears that, given the pressure of more students with the added demand of one-to-one student administrative work, the instructor shortens his answers to technical questions in order to save time and also reduces his "Other" type activities.

An analysis of line waiting time indicates that the average time a student stands in line for an instructor was 1.6 minutes for both student-instructor ratios, but this finding may represent an artifact in that the 30/1 group students just did not want to stand in a long line, so they sat and waited for the line to shorten. This possibility makes accurate analysis of line time difficult, if not impossible.

The overall results then demonstrate that with the larger number of students more time, naturally, is spent on administrative duties. This time for "administrative duties" is created by shortening answers to technical questions and spending less time on "Other" type activities. The only clear indication of an effect on student achievenment as a result of the different ratios is an increase in the number of training hours needed to complete BE&E associated with the larger ratio. There were no indications that the 30/1 ratio had any consistent detrimental effects on student achievement in the BE&E course. A replication of this study is proposed by using multiple student-instructor ratios and by rigidly controlling student through careful assignment of students to Learning Centers to ensure equal abilities in all experimental condictions.

An implication of this study is that control of study time is definitely related to instructor activities and these activities must be carefully monitored and controlled if study time is to be minimized.

Table 1

MEAN BE&E TRAINING CONTACT HOURS FOR GRADUATES

Career Pattern	S-I Ratio 18/1 $\bar{x}$	SD	(N)	30/1 $\bar{x}$	SD	(N)	
1	94.1	32.6	(10)	111.1	28.0	(27)	
2	190.5	41.4	(21)	243.3	62.3	(54)	$t_{(73)}=3.58, p<.001$
3	159.4	45.8	(14)	172.5	41.2	(28)	
4	129.7	31.5	(6)	120.9	28.4	(11)	

Table 2

MEAN FIRST-TRY TEST SCORES FOR GRADUATES IN MODULES 1-14

Career Pattern	S-I Ratio 18/1 $\bar{x}$	SD	(N)	30/1 $\bar{x}$	SD	(N)
1	85.8	7.8	(10)	89.8	5.7	(27)
2	87.3	5.0	(21)	85.9	5.5	(54)
3	89.9	3.3	(14)	87.3	5.8	(28)
4	81.9	1.1	(6)	82.4	6.9	(11)

Table 3

MEAN NUMBER OF UNSATISFACTORY SCORES RECEIVED ON

PRACTICAL TESTS FOR GRADUATES

Career Pattern	S-I Ratio 18/1 $\bar{x}$	SD	(N)	30/1 $\bar{x}$	SD	(N)	
1	1.2	.50	(4)	1.5	0.7	(9)	
2	4.7	2.9	(18)	3.8	2.4	(43)	
3	5.1	2.6	(12)	3.4	1.6	(21)	$t_{(73)} = 2.33, p < .03$
4	1.7	1.2	(6)	1.6	0.8	(7)	

Table 4

MEAN PERCENT OF INSTRUCTIONAL HOUR THAT

INSTRUCTOR PERFORMS EACH BEHAVIOR CATEGORY

	S-I Ratio						
	18/1			30/1			
Category	$\bar{x}$	SD	(N)	$\bar{x}$	SD	(N)	
Testing	22.6	6.9	(4)	28.9	1.7	(4)	
Administrative--Student	17.1	4.4	(4)	23.4	2.3	(4)	$F_{(1,3)}=6.38, p<.10$
Administrative--Non-Student	17.5	5.0	(4)	14.8	2.5	(4)	
Question	13.7	7.9	(4)	12.3	2.3	(4)	
Practical	4.0	1.5	(4)	4.8	2.5	(4)	
Non-School	0.7	.6	(4)	0.3	.2	(4)	
Other	24.5	11.0	(4)	15.5	6.1	(4)	

Table 5

MEAN TIME PER INSTRUCTOR BEHAVIOR

(IN MINUTES)

	S-I Ratio						
	18/1			30/1			
	$\bar{x}$	SD	(N)	$\bar{x}$	SD	(N)	
Testing	1.2	.3	(4)	1.1	.1	(4)	
Admin--Student	1.0	.1	(4)	1.0	.3	(4)	
Admin--Non-Student	1.6	.2	(4)	1.4	.2	(4)	
Question	2.2	.5	(4)	1.7	.3	(4)	$F_{(1,3)}=12.22, p<.05$
Practical	1.1	.5	(4)	1.0	.4	(4)	
Non-School	0.8	.6	(4)	0.5	.5	(4)	
Other	2.6	.1	(4)	2.4	.4	(4)	